THE DEMAND FOR HEALTH IN OSLO:

An Empirical Estimation of Grossman's Health Demand Model

Adam Mulugeta Wale

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Institute of Health Management and Health Economics

Faculty of Medicine

UNIVERSITY OF OSLO

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ABSTRACT

The objective of this paper is to test the theoretical implications of the Grossman health demand model and to examine the determinants of self-assessed health in Oslo. The data set consists of a cross-sectional, population based study conducted as a part of a general health survey known as the Oslo Health Study. Health capital is measured by a categorical measure of overall health status. An ordered probit model is used to econometrically estimate the demand for health equation. The results are consistent with the theoretical predictions of the Grossman's model. We found a decrease in the demand for health for age, weight, and smoking, we found an increase in the demand for health for level of education and marital status, organizational participation, and number of close friends. The effect of income was inconclusive: at lower levels of income, it was negatively significant, whereas at higher levels of income it was positively significant. Lifestyle variables such as drinking alcohol and smoking decrease the demand for health whereas doing physical activities increases health demand. The results also suggest that some inequity in health care with respect to nationality may be present in the current Norwegian health care system.

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1. INTRODUCTION

Since the last years, policy makers have shown an increased interest on population health and, in particular, on those characteristics of individuals that are related to health. Thus, the study of population health is an important goal in modern societies and demands careful attention for economic analysis. The determinants of health constitute an issue of vital importance to health policy, for example in establishing the effect of various non-medical influences on health such as unemployment or income.

Health is widely considered as an important component of human capital. Since the seminal work of Grossman (1972a, b), Grossman model has become standard model to study health demand and health determinants. Treating health as capital is the key insight of Grossman (1972). The health status reflects the stock of health capital.

In the Grossman model, the individual inherits an initial stock of health capital which depreciates over time but which may be augmented by acts of investment. It is useful to view health investment as embracing all types of health-promoting behaviour (consumption of effective medical care, healthy food, etc.) and to view health-damaging behaviour (consumption of cigarettes, alcohol, etc.) as affecting the rate at which health capital depreciates (Muurinen (1982a). Health capital can be formed as an individual invests time and money into market goods such as medical care, exercise, diet and recreation. By determining their health-related behaviour, individuals determine - at the margin - their stock of health capital and ultimately their length of life. Health is demanded by individuals both because it generates utility directly and because it affects the individual's performance in the labour market.

According to the model the demand for health increases with income, because as income increases the value of the labour time increases. Education should also increase the demand because more education makes health inputs more productive. Age and other factors that make health stock to depreciate will decrease the demand for health, because the marginal benefits into health will decrease. The price of health care decreases the health demand, because investments become more costly.

Applying Grossman model, economists have carried out numerous empirical studies, for examples: Wagstaff (1986), Erbsland et al. (1995), Sickles and Yazbeck (1998), and Dustmann and Windmeiher (2000) among others.

Following Grossmans model, the relationship between health lifestyle choices and health has attracted widespread attention and has resulted in a number of empirical extensions (Kenkel, 1995; Gerdtham et al, 1999). A wide range of socio-economic and health risk variables were considered in these extensions.

These empirical findings indicate that lifestyles have an impact on individual's health, diseases, and life expectancy. Cigarette smoking, excessive drinking and lack of exercise have negative consequence on the individual's health outcome. Several empirical studies have found a connection between social relationships and health (e.g. Berkman and Syme, 1979; Wolf and Bruhn, 1992; Berkman, 2000). A social network may, especially in times of stress (e.g. bad health), provide the individual with emotional, instrumental and informational support. Thereby it functions as an expansion of the individual's own resources. A social network may further exercise regulation and control over health related behaviours such as drinking and smoking.

The model is not, however, undisputed. A key criticism of the model is that it fails to take into account the uncertainty of the future health status and the uncertainty of the effects of investments in health production. For overviews of criticisms of the Grossman model, see van Doorslaer (1987) and Zweifel and Breyer (1997).

The objective of this paper is to test the theoretical implications of the Grossman health demand model using the categorical measure of health status as the measure of overall health status.

The data is based on a cross-sectional population study conducted as part of a general health survey known as the Oslo Health Study. The survey includes a self-reported categorical measure of health status. The advantage of using such a measure is that it is based on a simple survey question that has a high reliability. The drawback is that the question does not yield a continuous health status measure, which makes it more difficult to interpret the regression coefficients in a demand-for-health regression equation. As independent variables, we use a host of variables hypothesized to affect the demand for health. Variables that reflect lifestyle choices and socio-demographic conditions that are assumed to affect health are included.

The rest of the paper is structured as follows. In section 2 and 3 we discuss the theoretical and empirical model used in the study. In section 4 we briefly describe the data set and the measurement of variables employed in the empirical analysis. Section 5 presents estimation results and discussion. Section 6 summarizes the results and draws main conclusions.

2. THE THEORETICAL MODEL

The first formal economic model of the determinants of health was proposed by Grossman (see Grossman 1999 for an overview), who made a distinction between the demand for health and demand for health care. Grossman (1972) argues that 'good health' is a commodity produced by the individual. The commodity 'good health' is treated as part of his or her human capital, and as such it determines the total amount of time the individual can spend on productive activities in market and non-market sectors. Grossman constructed a model where individuals use medical care and their own time to produce health. Individuals were assumed to invest in health production until the marginal cost of health production equaled the marginal benefits of improved health status. Health status is assumed to affect utility directly by the value that individual place on good health per se and indirectly through increasing healthy time and hence, labor income.

Grossman (1972) presented a model where all individuals are born with an initial ''stock of health capital'' and has two important features (i) it depreciates over time and (ii) it can be increased by acts of investment in health. The main parameters in Grossman's model are depreciation rate (represented by age), cost of health investments (e.g. price of medical care), wage rate and education. Grossman (1972, p. 45) explains that ''the stock of health ... is a theoretical concept, one that is difficult to quantify empirically'' but that in contrast to difficulty in measuring health capital, ''healthy time output produced by health capital... could be measured easily.''

Grossman (1972) estimated gross investment production function by employing two stage least squares (2SLS) and the main explanatory variables were medical care, education, gender and income per household member. The reduced form demand function for health was estimated by OLS and included wage rate, education, gender and family size as the explanatory variables. His results showed that a change in model's parameters (age, education, wage rate and prices of medical care) changes the optimal level of health. Hence, an increase in income, holding prices and other production activities constant, results in more health output. The income effect operates through more use of health inputs that produce good health output. On the other hand, the effect of education is that education increases technical efficiency: educated people are able to produce a better health outcome for a given use of health inputs or use fewer inputs for producing the same level of health output.

According to the model, age and other factors that make health stock to depreciate will decrease the demand for health, because the marginal benefits of investments into health will decrease. Lifestyle, which is regarded as a key aspect in studying health, can be accommodated in Grossman framework. Lifestyle factors such as smoking, drinking, and exercising regularly affects health through two channels. One channel is the household technology. This channel captures the effect in health production process. Good behavior will make the production of health more efficient, whereas bad behavior will make it less efficient. The other channel is the rate of depreciation. Good behavior will decrease the rate of depreciation and hence the depletion of health capital will be slower. In contrast, bad behavior will increase the rate of depreciation and hence result in faster depletion of the stock of health capital. This channel captures the effect in consumption of health.

Following the standard model of Grossman (1972, 2000), we assume that the utility function of a representative consumer is as follows:

$$U=U(\Phi_t H_t, Z_t),\ t=0,1,...,n \tag{1}$$

where H_t is the stock of health capital at time t, φt is benefit produced by one unit of health capital, $h_t = \Phi_t H_t$ is the health consumed at time t, and Z_t is consumption for other goods at time t, and n is the length of life.

The initial stock of health capital H_0 is exogenous. H_t at any other age and the length of life n are endogenous.

The following equation describes the change of health capital;

$$H_{t+1} - H_t = I_t - \delta_t H_t \tag{2}$$

where I_t is the investment in health and δ_t is the rate of depreciation of health capital at time t. δ_t is changing with age.

I_t and Z_t are produced by the following equations:

$$I_t=I_t(M_t,TH_t; E) \tag{3}$$

$$Z_t=Z_t(X_t, T_t; E) \tag{4}$$

In this equation M_t is a vector of inputs (goods) purchased in the market that contribute to gross investment in health (e.g. Health care services); TH_t is the time allocated to improve health; X_t is similar vector of goods inputs that contribute to the production of Z_t. E is other exogenous component of human capital besides health, such as education. Equation (4) is home-production function for other consumption items Z_t.

Both market goods and own time are scarce resources. The goods budget constraint equates the present value of outlays on goods to the present value of earnings income over the life cycle plus initial assets:

$$\sum \frac{P_t M_t + Q_t X_t}{(1+r)^t} = \sum \frac{W_t TW_t}{(1+r)^t} + A_o \tag{5}$$

where P_t and Q_t are the prices of M_t and Q_t ; W_t is the hourly wage rate; TW_t is hours of work, and A_0 is initial wealth, and r is the market rate of interest. Besides budget constraint, the consumer also needs to meet the time constraint Ω.

$$TW_t + TH_t + T_t + TL_t = \Omega \tag{6}$$

where TW_t is time for working, and TL_t is the time lost from market and nonmarket activities due to illness and injury. The time constraint requires that Ω, the total amount of time available in any period, must be exhausted by all possible means.

Equations (1) to (6) constitute the Grossman model and they jointly determine the demand for health.

3. THE EMPIRICAL MODEL

Gerdtham *et al*. (1999) use Grossman's model to measure health capital. They measure the stock of health by a rating scale, a time trade-off, and a categorical health rating. In this paper, we estimate the demand for health using a categorical health rating (see also Gertdham *et al*., 1999, and Grossman, 2000).

In the last years new techniques allow us to deepen in the study of multinomial choice variables (Greene, 2003; Jones, 2000). In particular, we will focus our analysis on individuals´ self-assessed health (SAH). This variable takes four values that vary from "very bad" to "very good". The logit multinomial and probit multinomial models do not take into account that dependent variable reflects an order. In this way, regression analysis of SAH can be achieved through specifying an ordered probit model. Thus, our starting model is formulated through a latent health variable h* that it is unobserved (an individual's "true" health) and which depends on a linear combination of explanatory variables:

$$h^* = \beta' x + \varepsilon \qquad 7$$

where x is a set of explanatory variables, β a set of coefficients and ε an error term uncorrelated with the set of regressors with a normal distribution.

The dependent variable used is individual report of SAH. Thus, the higher value of our latent variable, the higher will be the probability that the individual reports a higher category in the self-assessed health scale. However, h* is unobserved and what we do observe is:

$$h_i = j \text{ if } \theta_{j-1} < h_i^* < \theta_j , \quad j = 1,2\ldots\ldots m \qquad 8$$

where θ_j = 0, 1, 2, are unknown cut-points to be estimated with β.
Assuming a normal distribution F of h_i*, the probabilities are respectively:

$$P_{ij} = P(h_i = j) = F(\theta_j - x_i\beta) - F(\theta_{j-1} - x_i\beta) \qquad 9$$

Estimates of β and the cut-points θ_m can be obtained by maximum likelihood estimation.

The sign of the coefficients shows the tendency of the variation in the probability of belonging to the highest answer due to an increment in the corresponding explanatory variable and the marginal effect of a regressor on the probability of belonging to each category is as follows:

$$\frac{\partial \sum \Pr(H = 0)}{\partial X_k} = -F(\theta_1 - X_i\beta)\beta_k, \qquad 10$$

$$\frac{\partial \sum \Pr(H = 1)}{\partial X_k} = [-F(\theta_2 - X_i\beta) + F(\theta_1 - X_i\beta)\beta_k], \qquad 11$$

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$$\frac{\partial \sum \Pr(H = M-1)}{\partial X_k} = -F(\theta_{(M-1)} - X_i\beta)\beta_k, \qquad 12$$

3.1 Hypothesis

We expect a positive sign for increase in years of education following Grossman (1972), who assumes that education increases the production of health because higher educated people are more efficient 'producers' of health .

We expect a positive sign for women. The rate of depreciation is assumed to be higher for men, since they have a lower life-expectancy.

As for being married/cohabiting a positive sign is expected following Gerdtham et al. (1999), who found a negative relation between living alone and health. People who are married or live together might take better care of their health in paying more attention to what they eat, in the time they take to relax, and in the time they take to sleep. We expect that overall individuals who are not married will have poorer health than those who are married because they are less likely to experience the emotional support and economic security that often accompanies marriage.

In fact, higher income should be associated with better health although this relationship is not clear and correlation can vary from highly positive to weakly negative, depending on context, covariates and level of aggregation (Fuchs, 2004).

Increase in weight will affect health negatively, because it increases the risk of coronary heart diseases, cardiovascular diseases, and cancer (Philipson, 2001; WHO, 2000; McGrinnis and Foege, 1993).

Drinking alcohol and smoking are expected to affect health negatively since they increase the depreciation rate for health capital. The effect of ethnicity is expected to be negative, since the literature shows a poorer health for immigrants generally (Stronks et al., 2001b; Reijneveld, 1998).

Unemployment is associated with a low socio-economic status and lower incomes and therefore a poorer health (Reijneveld, 1998; Weide and Foets, 1998; CBS). The lower one's wage, the smaller the marginal health utility due to less investment in own health (Grossman, 1972). Therefore we hypothesize a negative relation between unemployment and health.

The higher the amount of social capital, the larger is the probability that the respondent reported a high level of health. Other empirical results embodied in the estimates of the demand-for health equation merely confirmed the results obtained by Bolin et al. (2002b). Physical activities such as light and hard activities are expected to have a positive sign since both will decrease the depreciation rate of health capital. Summary of the expected signs for the variables under consideration is shown below:

Variable	**Expected sign**
Gender	+
Being married or cohabiting	+
Drinking alcohol	–
Years of education completed	+
Light physical activity	+
Hard physical activity	+
Having close friends	+
Organizational participation	+
Body Mass Index	–
Ethnicity	–
Age	–
Income	+
Unemployment	–
Smoking	–

4. DATA SET AND MEASUREMENT OF HEALTH

4.1 Data

In this study, we have analysed data from a cross-sectional, population based study conducted as a part of a general health survey known as the Oslo Health Study (HUBRO). The survey was linked to a wide range of public register data. This survey was jointly organized during 2000–2001 by the University of Oslo, National Health Screening Services of Norway (now the Norwegian Institute of Public Health), and Oslo Municipality.

The population targeted by the HUBRO survey includes all residents of Oslo born in the years 1924-25, 1940-41, 1955, 1960 and 1970, a total population of 40,888. The response rate was 46 per cent, leaving a net sample of 18,770 individuals.

Because of limitations in the statistical software, all missing cases for all of the variables had to be filtered off. In addition, respondents from 1924-25 age groups in Oslo were excluded, because they have a lot of missing values compared to the other age groups. As a result, the sample size after deletion of cases with missing information was 9136.

4.2 Measures and definitions

The dependent variable in this study is self-reported general health recorded against a four items response; bad, not so good, good and very good. The subjects were questioned about their present state of health, and their responses were recorded accordingly. A grading of a very good and good self-rated health was considered to reflect a good state of health, and a poor or very poor grading reflected a poor state of health.

Individual control variables in the regressions include the following variables: gender and age; Gender is represented by a 1-2 dummy for Female. The variable gender is included to control for possible differences in the rate of depreciation between the sexes due either to biological differences or to lifestyle differences (Muurinen, 1982b). We used three 0-1 dummies for age groups (AGE1, AGE2, AGE3 and AGE4). Education was measured as the number total school years completed.

Individual income was provided by the respondents in a range from none to more than 400 thousand Norwegian Kroner (NOK); 1 euro ≅ 8 NOK. This income was categorized into five levels as Income1 (no income to 100 thousand NOK), Income2 (100 to 200 thousand NOK), Income3 (200 to 300 thousand NOK), Income4 (300 to 400 thousand NOK) and income5 (>400 thousand NOK). We used four 0-1 dummies for the income groups. We use one proxy variable for the initial inherited stock of health capital which is Body mass index (BMI) calculated as the weight in kilograms divided by the square of the height in meters.

Marital status is included to examine the effects of companionship on health capital depreciation. Respondents were categorized into two categories with respect to their civil status, i.e. married and unmarried. The married category included all those who were either married or registered partners. Unmarried, separated/ divorced/do not live together and one partner alive were placed under the category of unmarried. As a measure of civil status we include a 0-1 dummy variable for if the individual is married or registered partner. Those respondents who are not married, separated, divorced, etc were considered as unmarried and are the reference category.

Ethnicity was determined on the basis of country of birth. The variable measuring non-western immigrant status consists of people who were born outside Europe. Ethnicity is represented by a 0-1 dummy for non-western immigrants, thus the Europeans (including those born in Australia and North America) are the reference category.

In addition, individual social capital indicators are used: Participation in voluntary organisations is measured by the question; "In how many organisations or organized groups do you participate during your leisure time?" (Responses were either 'zero' or given in whole numbers.) This question was coded as a binary response (0 for 'zero' and 1 for one or more organisations). Having close friends is measured by the question "How many close friends do you have?" and responses were the number of friends

At the time of survey respondents were asked about their employment, and the response was recorded against a three item categories, i.e. yes, full time; yes, part time; and no. We used a 0-1 dummy variables for if the individual is currently unemployed, part-time-employed and full-time employed. Besides we have used 0-1 dummy variables for if the individual is currently smoking, earlier, or never at all. A single structured question measured the overall frequency of drinking: ‘How often do you drink alcohol?’ Respondents were dichotomised as ‘drinkers’ if the answer was ‘daily’ or ‘2 - 3 times a week’, and ‘non-drinkers’ when the response was ‘2 - 3 times a month’, ‘a few times a year’ or ‘never’. Refer table-1 and 2 for the definition of the variables and their descriptive statistics

4.3 Descriptive statistics

It is well known that the health of a general population has a very skewed distribution, with the great majority of respondents reporting their health to be good to very good. Table 3 provides the distribution of SAS in the data set. Overall, 24 per cent of participants reported ‘very good’ health compared to 58 per cent reporting ‘good’ and 16 per cent reporting ‘not so good’. A very small fraction of the respondents (1.3 per cent) reported that their health status as bad.

In Table 2 we see that 31.07 per cent of our sample is aged 30 years, 23.07 per cent is aged 40 year, 20.55 per cent aged 45 years and 25.31 per cent aged 60 years. We also see that 54.27 per cent of our sample is composed of women, 46.53 per cent are married, and about 5 per cent are non-western immigrants. Mean proportion for participation in voluntary organizations is 52 per cent. The mean number of close friends for the participants is around 8 ranging from 0 to 99. See table for the description of other variables.

From Table 4 we see that 58.51 per cent and 12.44 per cent of the respondents from the women population do light and hard physical activities three hours or more per week respectively, whereas, 51.22 per cent and 19.69 per cent of the men population engage in light and hard physical training respectively. The proportion of women who presently smoke cigarettes is 27.91 per cent; whereas the corresponding figure for the male population is 25.94 per cent. The proportion of women who drink alcohol more than 2-3 times a week is 24.79 per cent and the corresponding figure for men is 36.55 per cent.

5. RESULTS AND DISCUSSION

5.1 Results of ordered probit analyses on health for the basic model

We have used ordered probit models for the whole sample (the basic model), as described in section 3, because they have several advantages compared with other econometric methods in the treatment of categorical ordered variables as in our case. Results have been obtained using STATA 10.0. Estimation of the models is based on the method of maximum likelihood and results are presented in Table 5 for the basic analysis. A negative sign of the coefficients indicates that increase in the respective variable improves the probability of very good health status and lowers the probability of a very poor health.

The table also includes estimates of the threshold parameters θ_1, θ_2 and θ_3 (denoted as Cut1, Cut2, and Cut3). These imply that, for example, a value of the latent variable less than -2.90 corresponds to bad health, a value between -2.90 and -1.38 corresponds to not so good health, a value between -1.38 and 0.47 corresponds to good health, and a value above 0.47 corresponds to very good health. The cut points can be interpreted in terms of z-scores (Greene, 2003). That is, the boundary between bad and not so good health is at z = -2.90, the boundary between not so good and good health is at z = -1.38 and the boundary between good and very good health is at 0.47.

It is not surprising to note that education coefficients maintain statistical significance showing that more education leads to an increase in the probability of reporting good health i.e. is, increase in levels of years the education increases the demand for health. This indicates that more education level is more productivity enhancing than lower education levels. Another explanation is that education changes tastes or preferences in a manner that favors health relative to certain other commodities.

Our findings of the effect of education on health also confirms with other studies conducted in other countries. For instance, education is a strong predictor of morbidity in Australia. Individuals with higher levels of education report fewer serious chronic and recent illnesses and better mental health than individuals with lower levels of education, even when controlling for the effects of other socio-economic factors. Relatively poorly educated men are 23 per cent more likely to have serious chronic illnesses and 90 per cent more likely to perceive their health as only fair or poor. Similarly, relatively poorly educated women are 15 per cent more likely to have serious chronic illnesses and twice as likely (i.e., 101 per cent more) to perceive their health as only fair or poor (National Health Strategy, 1992).

Education can mean an increased capacity to assimilate information, access health services, and make better decisions about lifestyle factors influencing health (Leeder 1993). Marmot found that a significant proportion of the inverse association between socio-economic status and health can be explained by the variable of "control" a person has over their life (Marmot 1997). In this way, concepts like self-efficacy (the capacity to control own circumstances) explain the close relationship between health and education (Fuchs 1992).

Alternatively, causality may be opposite, meaning that healthier people obtain more easily education (Grossman 1999). In addition, to interpret the result on education, it is necessary to point out that in our analysis we cannot model unobservable factors such as ability. If the correlations between ability and education and between ability and health are both positive, our result on education will be bias upward due to omitted variable bias (see Grossman, 2000).

We can also observe that some personal characteristics, such as being woman, have a positive and significant impact on individuals' health. The three age dummies are significantly negative (the base is 30 year olds) and the magnitude is larger for older groups who are more likely to experience worse health outcomes.

People with strong social ties have better health than people who are socially isolated (Davis and George, 1993). Strong social ties reduce the impact of stress on health (IBID).

The theoretical prediction concerning the effect of social capital on the level of health was confirmed; the higher the amount of social capital, the larger was the probability that the respondent reported a high level of health. Both of the indicators used for individual social capital (having at least one close friend and participation in organisations) are positively associated with general health. However, causality could not be determined from the cross-sectional survey data. One can, for instance, easily argue that healthy people are more likely than unhealthy ones to belong to sports organizations, or that it might be easier for healthy people to have close friends.

We can also see that regular smoking and drinking strong alcohol have a negative significant effect on health demand, because these variables increase depreciation rate of health capital. The two smoking dummy variables are clearly significant. The coefficient of smoking3 is significantly higher than the corresponding coefficient of smoking2. This clearly shows that those who do not smoke have definitely better health status compared to individuals who either smoked earlier or are now smoking.

Physical activity, on the other hand, increases demand for health, because it decreases depreciation rate of health capital. This means that the degree of physical activities as measured by the number of hours of physical activities per week, affects health positively. The two sport dummy variables are clearly significant, i.e., individuals who exercise regularly have a better health status compared to individuals who pursue mainly sedentary leisure activities. The coefficient of light physical activity is smaller than the corresponding coefficient for hard physical activity indicating that the later contributes more to a better health. This result was consistent with the finding by Gerdtham et al. (1999). However, we would like to stress that interpreting this result should be done carefully, because of endogeneity since people with a poor health will do no sports at all. The effect of physical activities on health increases with the frequency of doing it (Iversen, 2008).

When we consider the variable income the signs for the coefficients vary among the different income groups. Income group 2 and 3 do not have the expected signs a priori and not significant for group 3. Income groups 4 and 5 have the expected positive coefficients in line with the predictions of the Grossman model. However, we can still conclude that in general the prediction of the Grossman's model holds.

Being married is statistically significant and is associated with better health as the smaller p-value shows and it has an important impact on individual´s health. Also, we can observe in the table that employment has clear positive effect on individuals´ health. On the other hand, the coefficient for the variable related to initial health status, i.e. body mas index (bmi) is significant and increases the probability of individual reporting bad health status as expected.

Although Norway is a highly egalitarian affluent welfare country, health inequalities are marked, and this is especially true for Oslo, the capital city (Claussen and Næss, 2002; Sund and Krokstad, 2005). Equality has been a central political goal and cultural value for decades. Despite major welfare reforms and universal access to health care resources, the social differences in health are substantial in Oslo. Public health policy has not been effective to reduce these inequalities in health.

In light of this it is not surprising that the coefficient of non-western immigrants is significant and negative. These findings are similar to findings in other countries. For example, a number of studies have shown that most British ethnic minorities have higher mortality and morbidity rates compared to the majority ethnic British population (Harding and Maxwell, 1997). The reported mortality in immigrants with South-Asian descent in the UK caused by coronary diseases is 40 percent higher than that of Europeans (Balarajan, 1991). This seems to be linked to the higher prevalence of diabetes in this group (Mather and Keen 1985). In general, mortality from both cardiovascular diseases and diabetes is more common in immigrant communities especially from South Asia (Mather et al., 1998). Similar results have been found for South-Asians immigrants in other countries (Mather and Keen 1985).
The number of non-western immigrants in our data was small, and the results should therefore, in general, be interpreted with caution.

It is widely accepted that unemployment is strongly linked to poor health (Davis and George 1993, World Health Organisation, 1998). For example, the results of the National Health Survey in Australia demonstrate that, even irrespective of the impact of income levels, unemployment is independently associated with poorer health. In our result the effect of unemployment is negative and significant and is up to our expectation.

5.2 Results of ordered probit analyses on health based on gender

In Table 6 and Table 7 we report the ordered probit estimated effects of the covariates on the categorical health measure based on gender.

In both sexes age significantly decreases health i.e. the estimated effects of age2, age3, and age4 is significant ($P<0.01$). As in the full sample, we see that the estimated effects of not drinking alcohol, light and hard physical training, and education are positive and significant as expected. Both in the basic and reduced models married male and female have better health than their single counter parts do. However being married has insignificant ($p=0.645$) effect on health demand for male as shown in the model for male.

The estimated effect of ethnicity (non-western immigrants) is significant ($p<0.01$) and has the expected in both models as the basic model. But the estimated negative effect becomes larger in the case of a woman which is -0.523. This indicates that women of non-western immigrant origin do have much poorer health compared to their counterparts in Europe and their fellow countrymen. This could either be due to the difference lifestyles, food consumption patterns or genetic predispositions resulting in difference health effects.

To further understand the effects of some of the variables in the model on health, the marginal effects of these variables for a very good health status are presented in Table 8 (for the basic model). We see that being 60 years (as opposed to 30 years) is associated with about a 12.09 per cent decrease in the predicted probability of being in a very good health category, being 45 years is associated with a 6.77 per cent decrease in the predicted probability of being in very good health status, and being 40 years is associated with a 2.86 per cent decrease in the predicted probability of being in very good health status.

Being totally non-smoker raises the probability of being in excellent health by 9.4 per cent, while being earlier smoker raises the probability of being in excellent health by 6.35 per cent. In addition, the probability of being in excellent health decreases if the respondent is non-western immigrant (about 11.03 per cent).

When individuals do exercise hard physical activities, are members of organizations and do consume little or no alcohol, the probability that they report very good health increases by 11.93 per cent, 2.8 per cent and 2.6 per cent respectively.

Unemployment reduces the predicted probability of being in very good health by 15.76 per cent where as for those who work part-time, the corresponding reduction is 5.21per cent compared to those who are full-time employed.

6. CONCLUSION

The empirical investigation of the Oslo data supports more or less the predictions of the theoretical predictions of the Grossman model. Using self-assessed health status we found that increases in the variables that increase depreciation of a health capital such as age, smoking, and drinking reduce health demand.

The variables that decrease the depreciation rate such as increased in social capital as measured by the number of close friends and organizational participation, physical activities, and marital status increase the demand for health.

The effect of income seems to be discontinuous: for low income levels a rise in income decreases the demand for health, but for high income levels the demand for health increased.

In spite of Norwegian health care system, which generally guarantees health care for everyone, non-western immigrants have lower health status. It may, of course, be explained by some kind of genetic differences of different nationalities, but it may also be a sign that there is some inequity in health and health care present in the current system.

Finally we end by referring to some limitations of the study. We did not include the price of medical care or the possession of public health insurance in the estimation equations, because they were not available. In general, public health insurance is available to every person who is residing in Norway, therefore we expect that the prices are similar to every individual and their exclusion does not affect the results significantly.

There may be other omitted variables which were not accounted in this paper such as place of residence. Differences in lifestyle risk factors between groups of different socio-economic status may partly be due to differences between the groups exposure to both physical and social environments that support a healthy lifestyle. The most deprived still tend to live in the list attractive areas where elements like crime, violence, pollution, noise, crowding, and lack of leisure facilities are parts of their daily lives (Rognerud et al., 1998)

A second limitation concerns causality. For some variables there could be problems with reversed causality, for example, health status may affect income and education rather than the other way round. If this is the case, then the estimated effects of income and education will be biased, along with the effects of all other correlated regressors. The lack of instruments precludes formal tests of possible endogeneity and our results therefore need to be interpreted with some caution.

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8. LIST OF TABLES

Table 1. Description of variables used in the model

Variable name	Definition
Dependent variables	
SAH_01	Assessment of own health on a four-point scale (1=bad health, 1=not so good health, 3=good health, and 4= very good)
Independent variables	
gender	= 2 if female, 1 if male
Maritalst_01	= 1 if married or partnership
Drinkalk_01	=1 if drinking alcohol ≥ one times a week
Education_1_01	= Years of education completed
Lightsport_01	=1 if No. hours per week during leisure time with light physical activity ≥ 3 hours
Hardsport_01	=1 if No. hours per week during leisure time with hard physical activity ≥ 3 hours
friends_01	=1 if 2+ close friends
Orgpart_01	=1 if one or more organizations
bmi_01	= Body Mass Index
Ethnicity_01	=1 if non-western immigrant(non European)
age1	= 1 if age= 30 years
age2	= 1 if age= 40 years
age3	= 1 if age=45 years
age4	= 1 if age= 60 years
Income1	= 1 if the gross annual income is< 100000 kr.
Income2	= 1 if the gross annual income is between 100000 – 200000 kr.
Income3	= 1 if the gross annual income is between 200000 – 300000 kr.
Income4	= 1 if the gross annual income is between 300000 –400000 kr.
Income5	= 1 if the gross annual income is >400000 kr.
employ1	=1 if full time employed
employ2	=1 if part time employed
employ3	=1 if unemployed
smoking1	=1 if yes now
smoking2	=1 if yes earlier
smoking3	=1 if never

Table 2. Descriptive statistics of the variables used in the analysis

Variables	Mean	Std. Dev.	Min	Max	Obs
SAH_01	3.056918	.6750218	1	4	9136
gender	1.542688	.4982016	1	2	9136
Maritalst_01	.4653021	.4988219	0	1	9136
Drinkalk_01	.3016637	.4590052	0	1	9136
Education~01	14.75679	3.752052	0	38	9136
Lightspor~01	.5517732	.4973395	0	1	9136
Hardsport_01	.1576182	.3644026	0	1	9136
friends_01	8.574759	6.625711	0	99	9136
Orgpart_01	.5249562	.5564283	0	11	9136
bmi_01	25.50271	4.034134	15.4	49.2	9136
Ethnicity_01	.0485989	.2150399	0	1	9136
age1	.3107487	.4628254	0	1	9136
age2	.2307356	.4213266	0	1	9136
age3	.205451	.4040529	0	1	9136
age4	.2530648	.4347916	0	1	9136
Income1	.0723511	.2590826	0	1	9136
Income2	.1637478	.3700668	0	1	9136
Income3	.3579247	.4794161	0	1	9136
Income4	.2304072	.4211165	0	1	9136
Income5	.1755692	.380474	0	1	9136
employ1	.7559107	.4295695	0	1	9136
employ2	.1279553	.3340584	0	1	9136
employ3	.116134	.320403	0	1	9136
smoking1	.2701401	.4440563	0	1	9136
smoking2	.2672942	.4425714	0	1	9136
smoking3	.4625657	.498624	0	1	9136

Table 3. Distribution of SAH in the whole sample of respondents

SAH_01	**Freq.**	**Percent**	**Cum.**
Bad	115	1.26	1.26
Not so good	1,491	16.32	17.58
Good	5,289	57.89	75.47
Very good	2,241	24.53	100.00

Table 4. Distribution of life style variables by gender (in per cent)

Lightsport_01	***gender***	
	1 (male)	2 (female)
0	48.78	41.49
1	51.22	58.51
Hardsport_ 01		
0	80.30	87.55
1	19.69	12.44
Drinkalk_0		
0	63.45	75.21
1	36.55	24.79
smoking		
1	25.95	27.91
2	27.93	25.72
3	46.12	46.37

Table 5. Results of ordered probit analyses on health (the basic model)

```
Ordered probit regression                         Number of obs   =       9136
                                                  Wald chi2(       21)  =    1676.40
                                                  Prob > chi2     =     0.0000
Log pseudolikelihood =    -8313.0864                  Pseudo R2       =     0.1009
```

SAH_01	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
gender	.0656663	.027153	2.42	0.016	.0124474	.1188852
Maritalst_01	.060845	.0260579	2.33	0.020	.0097725	.1119175
Drinkalk_01	.0877768	.0275512	3.19	0.001	.0337775	.1417762
Education~01	.0200197	.003643	5.50	0.000	.0128796	.0271599
Lightspor~01	.1375777	.024997	5.50	0.000	.0885844	.1865709
Hardsport_01	.3728049	.0364198	10.24	0.000	.3014234	.4441863
friends_01	.0147171	.0020277	7.26	0.000	.0107428	.0186913
Orgpart_01	.0946108	.0229085	4.13	0.000	.049711	.1395106
bmi_01	-.0375874	.003173	-11.85	0.000	-.0438063	-.0313685
Ethnicity_01	-.4518888	.0587542	-7.69	0.000	-.5670449	-.3367326
age2	-.099862	.034944	-2.86	0.004	-.168351	-.0313731
age3	-.2456727	.0362075	-6.79	0.000	-.316638	-.1747073
age4	-.4547262	.0366145	-12.42	0.000	-.5264893	-.3829632
Income2	-.166444	.0569554	-2.92	0.003	-.2780745	-.0548136
Income3	-.0992129	.0578775	-1.71	0.086	-.2126506	.0142249
Income4	.0658991	.0611989	1.08	0.282	-.0540487	.1858468
Income5	.2037064	.0645847	3.15	0.002	.0771227	.3302901
employ2	-.1888249	.0432496	-4.37	0.000	-.2735927	-.1040572
employ3	-.6843223	.0485044	-14.11	0.000	-.7793891	-.5892555
smoking2	.2092424	.0330008	6.34	0.000	.144562	.2739229
smoking3	.3179866	.030419	10.45	0.000	.2583664	.3776068
/cut1	-2.90479	.1374342			-3.174156	-2.635424
/cut2	-1.376639	.1292969			-1.630056	-1.123222
/cut3	.4676818	.1286946			.2154451	.7199185

Table 6. Ordered Probit results for women

```
Ordered probit regression                         Number of obs   =       4958
                                                  Wald chi2(    20)   =     928.60
                                                  Prob > chi2     =     0.0000
Log pseudolikelihood =  -4655.2127                   Pseudo R2       =     0.1003
```

SAH_01	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
Maritalst_01	.077109	.0353258	2.18	0.029	.0078718	.1463463
Drinkalk_01	.0805751	.0395462	2.04	0.042	.0030661	.1580842
Education~01	.0132576	.0049943	2.65	0.008	.003469	.0230462
Lightspor~01	.1376069	.0338114	4.07	0.000	.0713378	.2038761
Hardsport_01	.3806941	.0543822	7.00	0.000	.2741069	.4872812
friends_01	.0205159	.0030507	6.72	0.000	.0145366	.0264952
Orgpart_01	.0775566	.029837	2.60	0.009	.0190771	.1360361
bmi_01	-.0369623	.0040329	-9.17	0.000	-.0448667	-.0290579
Ethnicity_01	-.5925844	.0901777	-6.57	0.000	-.7693294	-.4158394
age2	-.0842722	.0469831	-1.79	0.073	-.1763574	.0078131
age3	-.2587581	.049398	-5.24	0.000	-.3555765	-.1619398
age4	-.522971	.0503371	-10.39	0.000	-.6216299	-.4243121
Income2	-.2013397	.0682583	-2.95	0.003	-.3351234	-.067556
Income3	-.1215074	.0718902	-1.69	0.091	-.2624096	.0193947
Income4	.0513145	.0791809	0.65	0.517	-.1038773	.2065063
Income5	.0719849	.0926396	0.78	0.437	-.1095854	.2535552
employ2	-.1490557	.0498054	-2.99	0.003	-.2466726	-.0514388
employ3	-.6750183	.062336	-10.83	0.000	-.7971946	-.552842
smoking2	.2258772	.0444681	5.08	0.000	.1387212	.3130332
smoking3	.3419656	.040983	8.34	0.000	.2616404	.4222907
/cut1	-3.126466	.1642973			-3.448483	-2.804449
/cut2	-1.500372	.1523239			-1.798921	-1.201822
/cut3	.2226935	.1506712			-.0726166	.5180036

Table 7. Ordered probit results for men

Ordered probit regression	Number of obs = 4178
	Wald chi2(20) = 777.81
	Prob > chi2 = 0.0000
Log pseudolikelihood = -3615.1721	Pseudo R2 = 0.1067

SAH_01	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
Maritalst_01	.0182372	.0396372	0.46	0.645	-.0594502	.0959245
Drinkalk_01	.1016426	.0390941	2.60	0.009	.0250196	.1782656
Education~01	.0256721	.005438	4.72	0.000	.0150139	.0363303
Lightspor~01	.1314623	.0374737	3.51	0.000	.0580152	.2049094
Hardsport_01	.3794579	.0505016	7.51	0.000	.2804767	.4784391
friends_01	.0093862	.0027182	3.45	0.001	.0040586	.0147138
Orgpart_01	.1164739	.034489	3.38	0.001	.0488767	.1840711
bmi_01	-.0379247	.0051244	-7.40	0.000	-.0479683	-.0278811
Ethnicity_01	-.3459354	.0802132	-4.31	0.000	-.5031504	-.1887204
age2	-.1293512	.0528619	-2.45	0.014	-.2329586	-.0257438
age3	-.2470807	.0539057	-4.58	0.000	-.3527339	-.1414275
age4	-.3884731	.0547828	-7.09	0.000	-.4958455	-.2811007
Income2	-.1226658	.1060048	-1.16	0.247	-.3304315	.0850998
Income3	-.0977136	.1006584	-0.97	0.332	-.2950004	.0995733
Income4	.0840425	.1023646	0.82	0.412	-.1165885	.2846734
Income5	.2760499	.1037735	2.66	0.008	.0726576	.4794421
employ2	-.3561561	.0875842	-4.07	0.000	-.527818	-.1844941
employ3	-.7016299	.0773231	-9.07	0.000	-.8531805	-.5500793
smoking2	.1938509	.0497055	3.90	0.000	.09643	.2912718
smoking3	.3103234	.0461889	6.72	0.000	.2197949	.400852
/cut1	-2.896622	.1996383			-3.287906	-2.505338
/cut2	-1.48493	.1889013			-1.855169	-1.11469
/cut3	.5251429	.1881175			.1564394	.8938465

Table 8. Marginal effects for the ordered probit model of the health equation (the basic mode). . Self-assessed health as indicator of health (SAH_01=4 i.e. very good.)

```
Marginal effects after oprobit
      y  = Pr(SAH_01==4) (predict, outcome(4))
         =   .21558434
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
gender	.0192173	.00796	2.42	0.016	.003625	.034809	1.54269
Marit~01*	.0178348	.00765	2.33	0.020	.002839	.032831	.465302
Drink~01*	.0260351	.00828	3.14	0.002	.009801	.042269	.301664
Educa~01	.0058588	.00107	5.49	0.000	.003768	.00795	14.7568
Light~01*	.0400244	.00724	5.53	0.000	.025833	.054216	.551773
Hards~01*	.1192642	.01258	9.48	0.000	.094601	.143928	.157618
frien~01	.004307	.00059	7.24	0.000	.003141	.005473	8.57476
Orgpa~01	.0276879	.00671	4.13	0.000	.014536	.04084	.524956
bmi_01	-.011	.00093	-11.79	0.000	-.012828	-.009172	25.5027
Ethni~01*	-.1102876	.01152	-9.57	0.000	-.132872	-.087703	.048599
age2*	-.0285983	.00978	-2.93	0.003	-.047758	-.009439	.230736
age3*	-.0676931	.00934	-7.25	0.000	-.086002	-.049384	.205451
age4*	-.1208501	.00876	-13.79	0.000	-.138029	-.103671	.253065
Income2*	-.0465221	.01515	-3.07	0.002	-.07622	-.016824	.163748
Income3*	-.0287073	.01655	-1.73	0.083	-.061147	.003733	.357925
Income4*	.0195525	.0184	1.06	0.288	-.016518	.055623	.230407
Income5*	.0626094	.02076	3.02	0.003	.021912	.103307	.175569
employ2*	-.0521374	.0112	-4.65	0.000	-.074099	-.030176	.127955
employ3*	-.1576047	.00831	-18.96	0.000	-.173894	-.141316	.116134
smoking2*	.0634996	.01037	6.12	0.000	.043178	.083821	.267294
smoking3*	.0937705	.00905	10.36	0.000	.076024	.111517	.462566

(*) dy/dx is for discrete change of dummy variable from 0 to 1